FE based performance estimation of PMBLDC motor based drives

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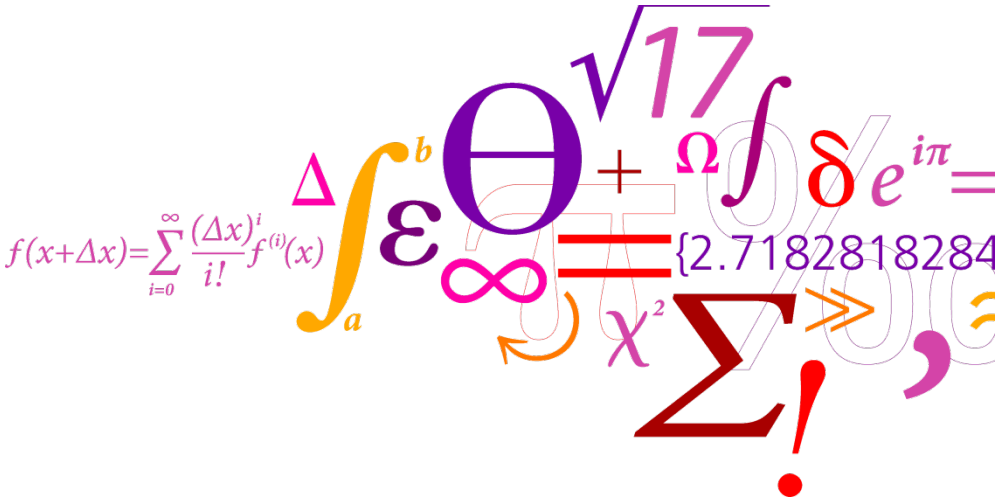
Presented by

Muhammed Fasil

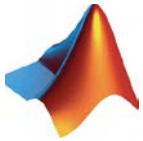
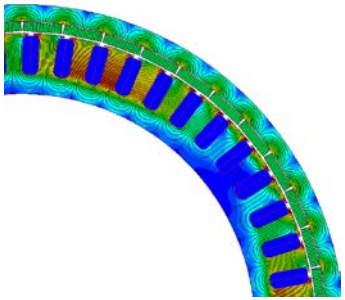
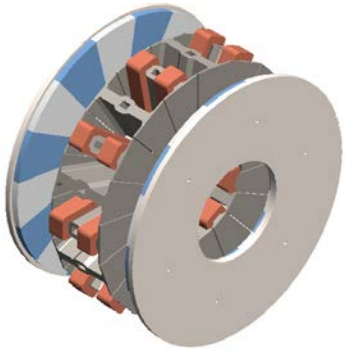
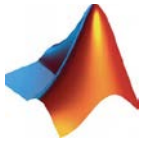
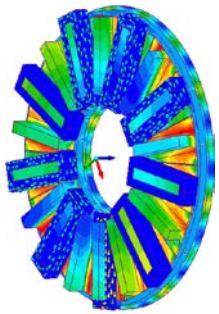
Ph.D. Student



DTU Electrical Engineering

Department of Electrical Engineering

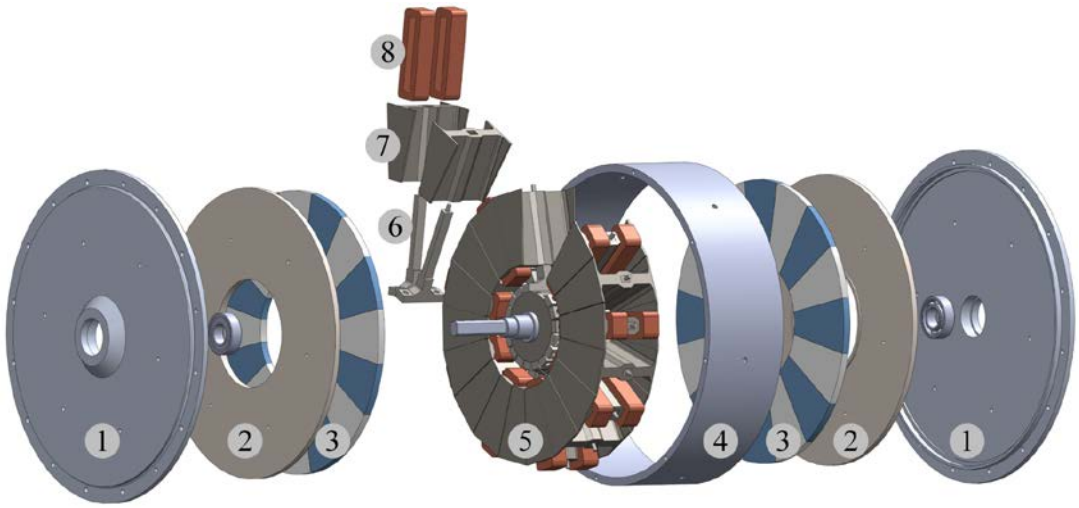
Background

Permanent magnet drive topology	Simulation method	Simulation time
Controller  Radial flux motor 	Circuit simulation software  PSpice 2D-Finite element software 	Hours
Controller  Axial flux motor 	Circuit simulation software  PSpice 3D-Finite element software 	Days

Outline

- Axial flux permanent magnet brushless DC (PMBLDC) motor for an electric two-wheeler
- Proposed approach for the performance simulation of PMBLDC motor drives
- Electromagnetic finite element (FE) model of PMBLDC motor
- System modelling of PMBLDC motor drives in circuit simulation software
- Results of ISO 13064 drive cycle simulation of electric two-wheeler
- Conclusion

Axial flux motor for electric two-wheeler

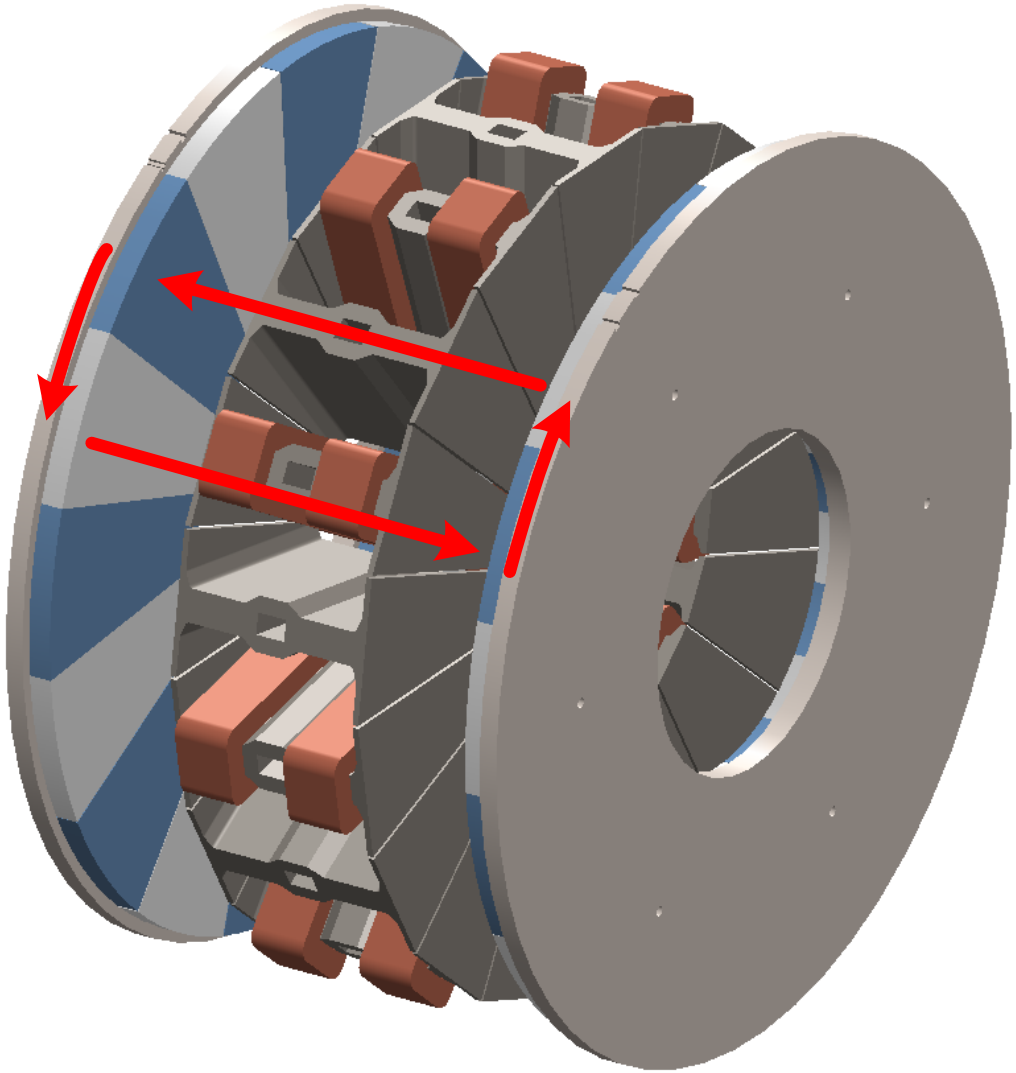


1. end cover, 2. rotor yoke, 3. magnet, 4. casing, 5. stator, 6. tooth holder, 7. stator tooth, and 8. coils

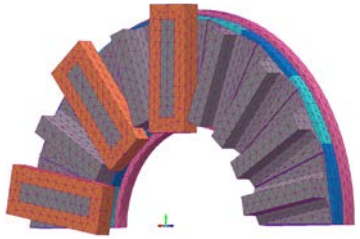
The specification and geometrical dimensions of ferrite magnet sat PMBLDC motor

Parameter	Value
The rated voltage	48 V
The rated power output	700 W
The rated torque	20 N m
Outer diameter of the motor	275 mm
Diameter ratio	0.45
Axial length of the motor	65.5 mm
Number of poles	16
Number of slots	18
Gross slot fill factor	0.5
Thickness of magnet poles	7.5 mm
Length of air gap	0.4 mm
Number of turns per coil	30
Diameter of a coil turn	2.68 mm

3D Flux path in axial flux machine

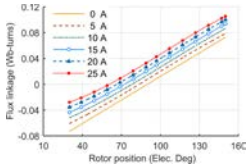


Proposed approach for the performance simulation of PMBLDC motor drives

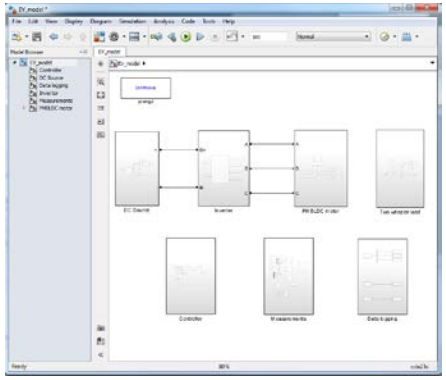


3D static FE model

- Flux linkage vs. rotor position
- Inductance
- Cogging torque vs. rotor position

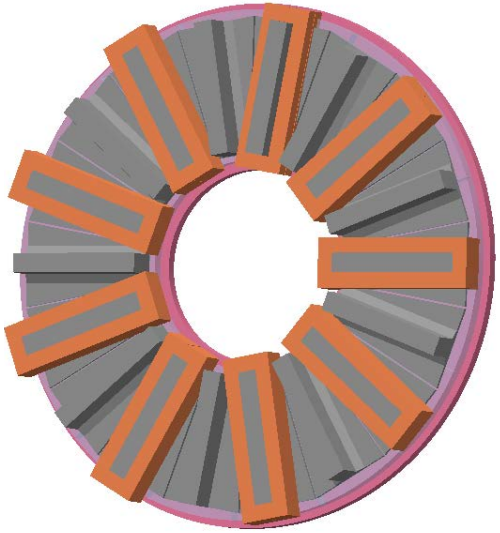


3D data table



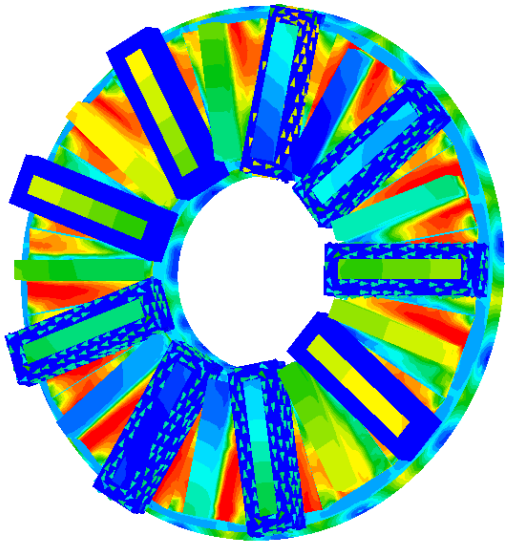
Circuit simulation softwares

Results from FE software



FE model utilizing geometrical symmetry

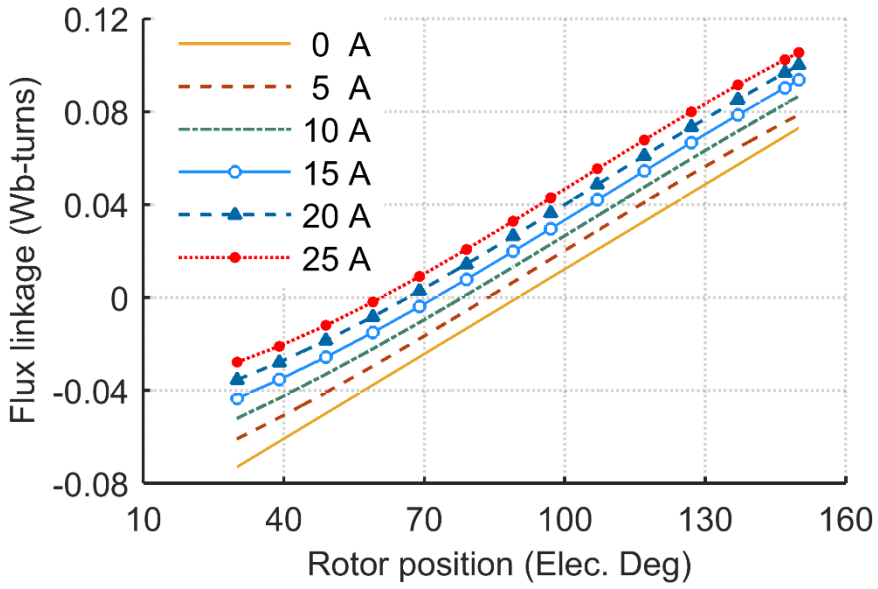
Meshed FE model



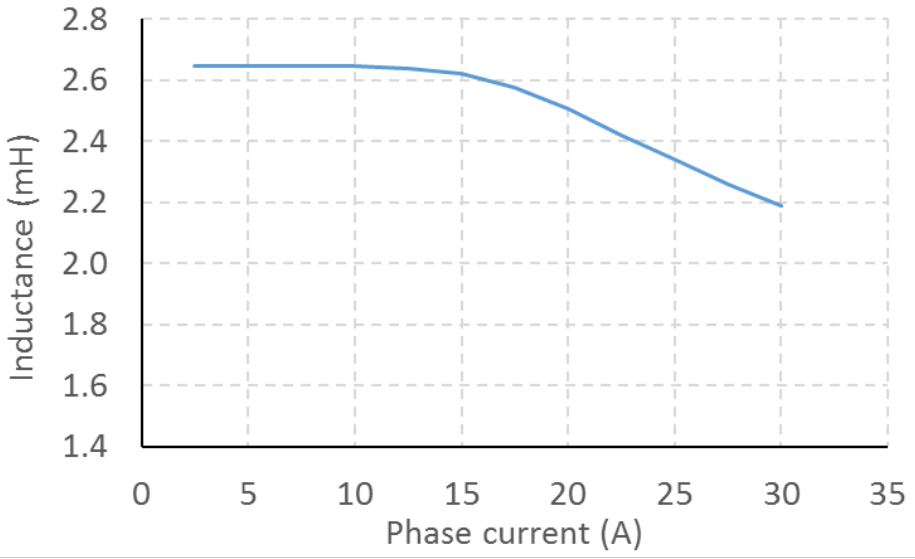
Static field solutions

Results from FE software

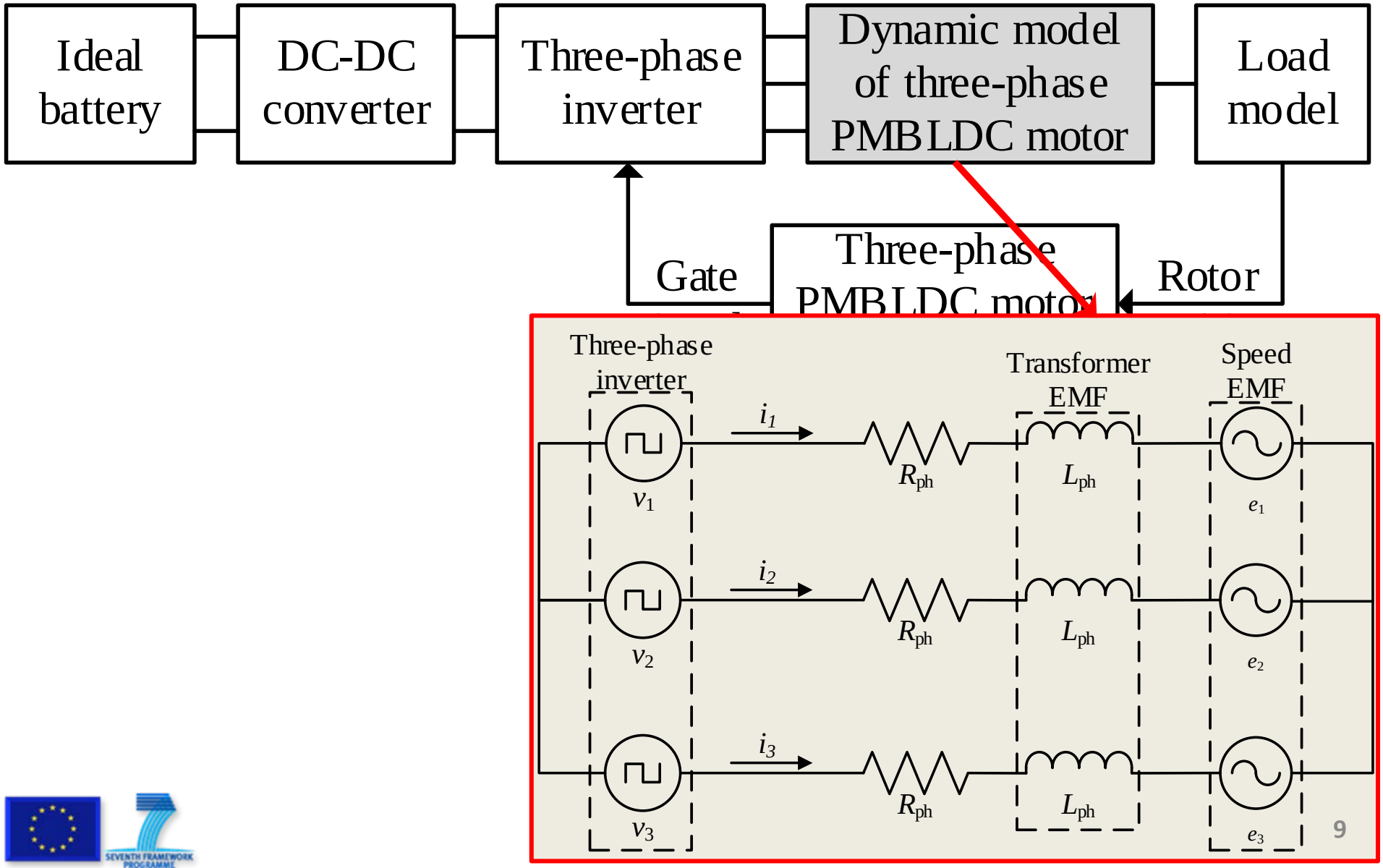
Flux linkage vs. rotor position for different phase current



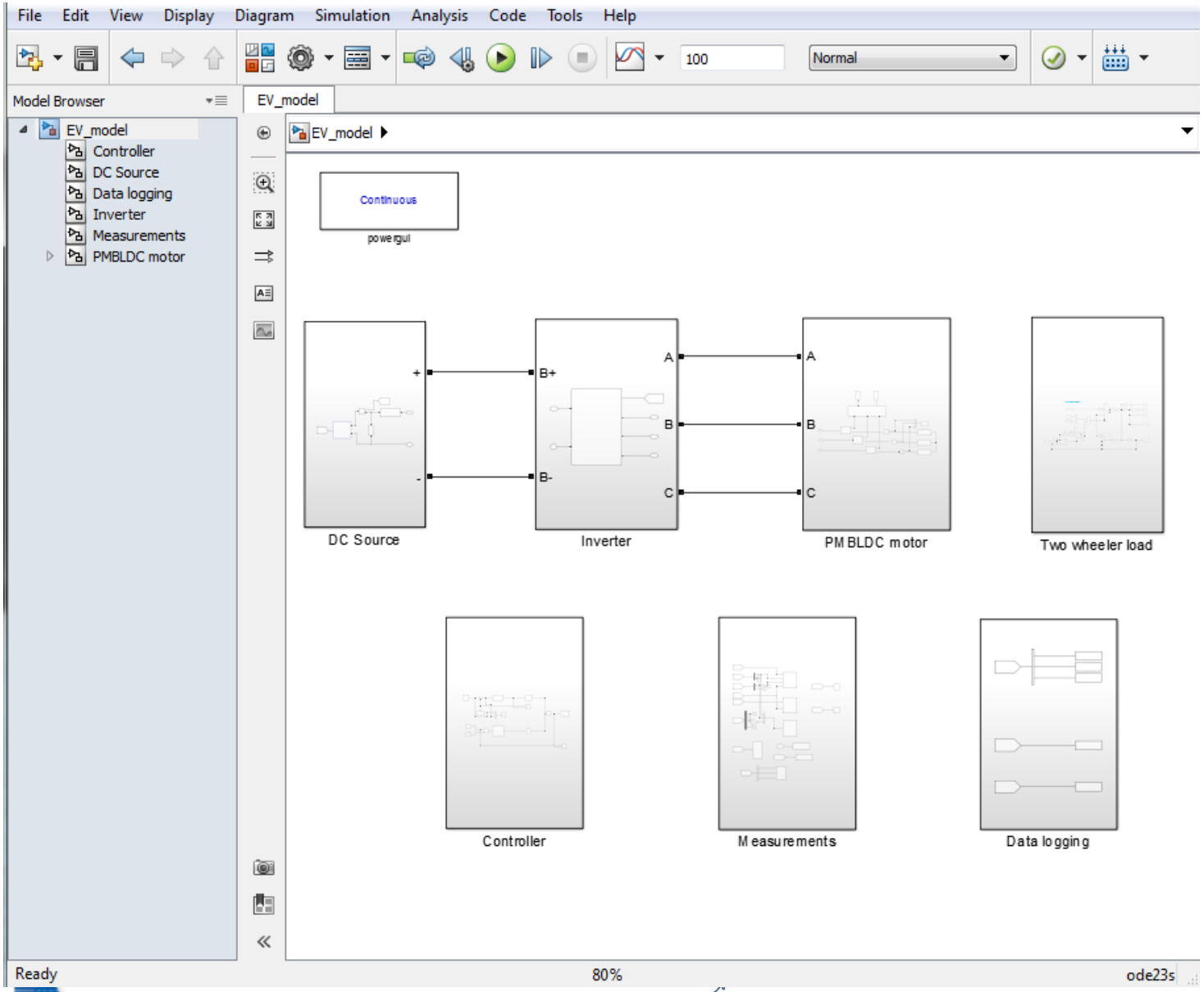
Phase inductance for different phase current



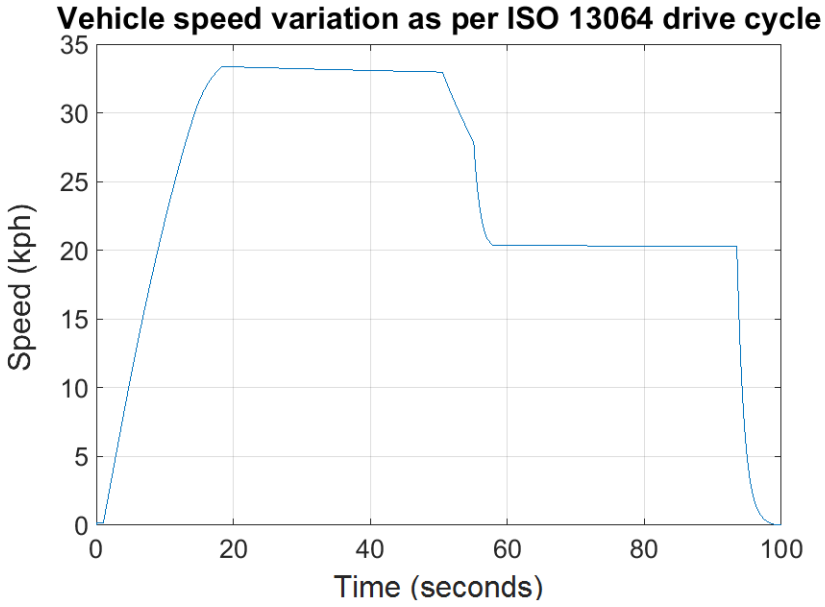
Mathematical model of PMBLDC motor drive in circuit simulation software

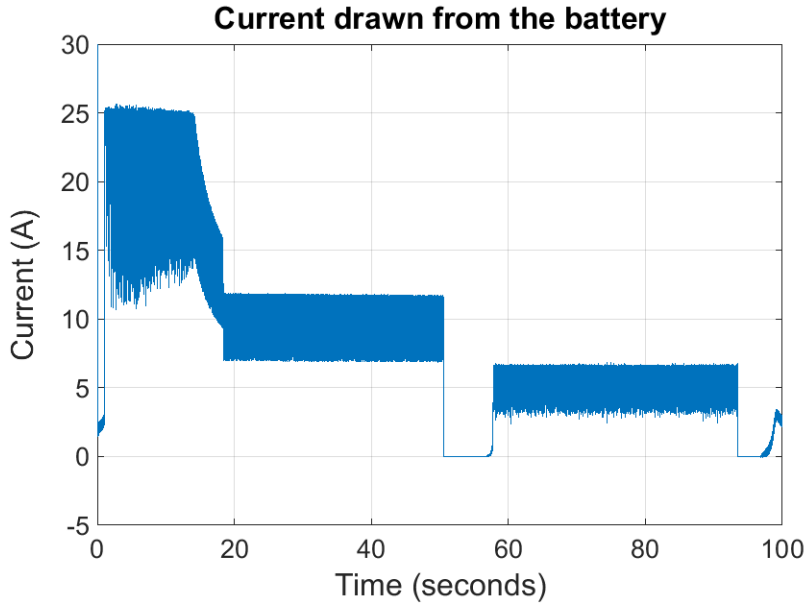


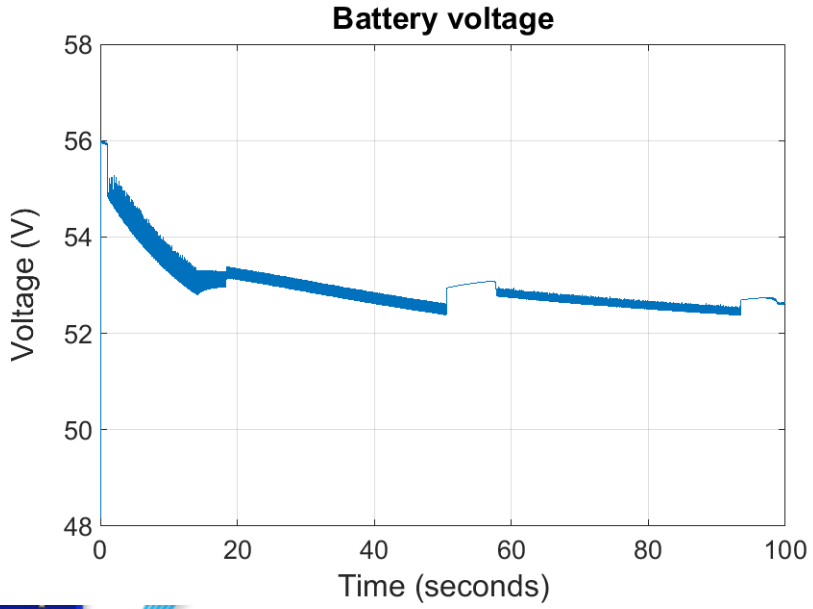
System model of electric two-wheeler in circuit simulation software

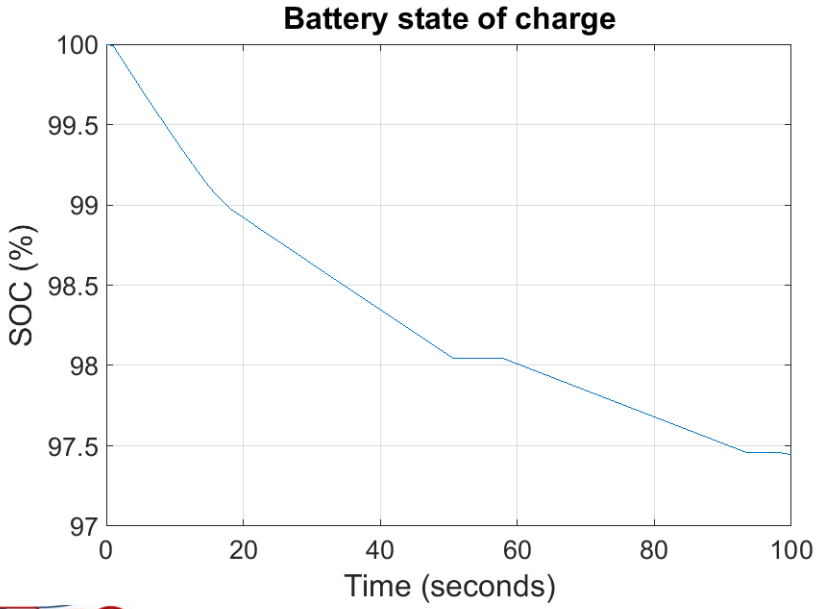


Results of ISO 13064 drive cycle simulation









Conclusion

- An accurate dynamic model of PMBLDC motor is developed based on the results from the electromagnetic finite element simulation
- Dynamic model helps to carry out accurate system studies of 3D machine topologies
- The proposed model is used to simulate the system performance of an electric two-wheeler when driven as per ISO 13064 drive cycle
- Experimental validation of the model will be done in coming months

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Consortium

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